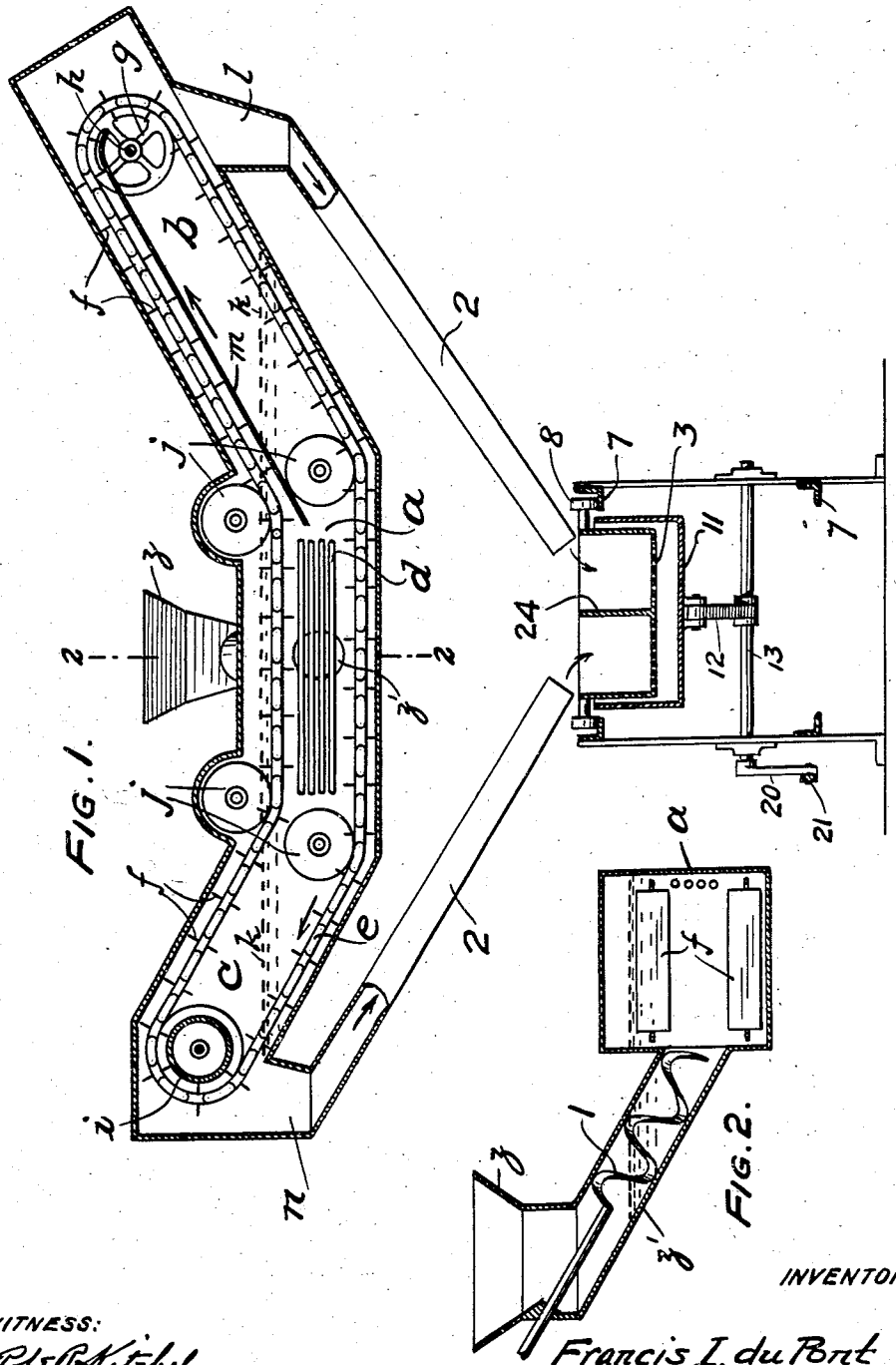
Aug. 9, 1932. F. I. DU PONT 1,870,613

METHOD OF SEPARATING COAL FROM IMPURITIES

Filed Jan. 28, 1930 2 Sheets-Sheet 1



WITNESS:
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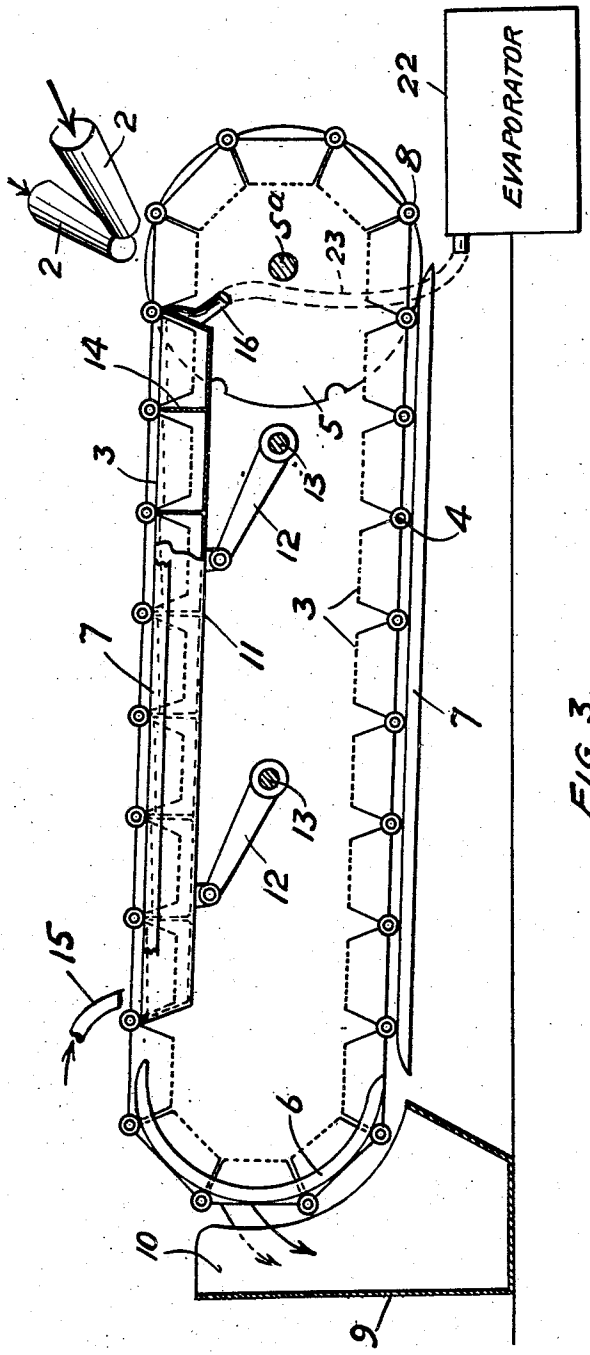


FIG. 3.

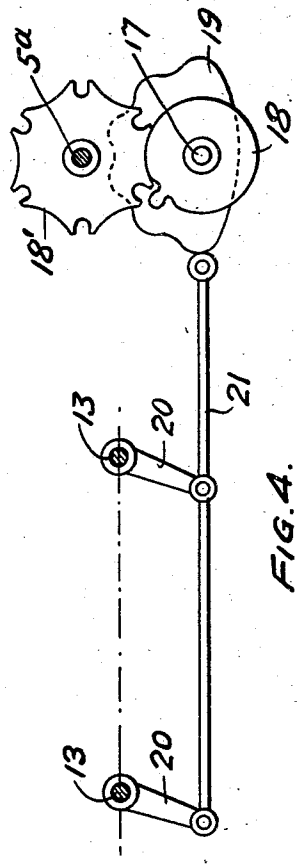


FIG. 4.

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UNITED STATES PATENT OFFICE

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METHOD OF SEPARATING COAL FROM IMPURITIES

Application filed January 28, 1930. Serial No. 423,925.

My invention relates to a method for effecting the separation of coal from impurities.

The method in accordance with my invention contemplates the separation of coal, which may be either bituminous or anthracite, from impurities, such as slate, shale, etc. through the medium of a solution which will enable the coal and impurities to be separated by gravitation.

In the practical adaptation of the method in accordance with my invention, the coal, suitably broken to free the impurities, may be placed in a bath of the solution and when the coal and impurities have been separated by gravity, the coal and impurities are separately withdrawn from the bath. Desirably, however, the method will be carried out in some suitable form of apparatus which will enable coal to be treated continuously and which will desirably, though not necessarily, be associated with some suitable means for recovering such part of the solution as is carried out of the bath with the coal and impurities.

In accordance with the method embodying my invention, I use a solution or melt of sodium thiosulphate ($Na_2S_2O_3.5H_2O$) melting point 32° C.–48° C., specific gravity approximately 1.63, when melted, as the solution to enable the separation by gravity of coal from its impurities, as slate, shale, etc. In the practical adaptation of the method the sodium thiosulphate will desirably be melted or in solution in its water of crystallization, through the use of a temperature at or somewhat above the melting point of the hydrated sodium thiosulphate used.

The practical adaptation of the method embodying my invention may best be illustrated with reference to the accompanying drawings in which:

Figure 1 is a view, mainly in section, of an apparatus for carrying out the method in accordance with my invention.

Figure 2 is a sectional view on line 2—2 Figure 1.

Figure 3 is a view, partly in section, showing a part of the apparatus shown in Figure 1.

Figure 4 is a view showing details of a driving mechanism.

Referring to the drawings *a* indicates the central horizontal section of a tank provided with inclined end portions *b* and *c*. The tank is provided with heating coils *d*. In the tank is a conveyor formed by a pair of chains *e* connected by flights *f*. The conveyor is driven by sprocket wheels *g* over which the chains pass and which are mounted on a suitably driven shaft *h*. The conveyor is supported by a pair of rollers *i* and guided by rollers *j*. The tank is designed to hold a bath of liquid, the normal level of which is indicated by the broken line *k*—*k*, and the conveyor is guided by the rollers *j* so that the upper reach of the conveyor travels through the liquid in the portion *a* of the tank on a line near the surface of the liquid, while the lower reach travels through the liquid adjacent to the bottom of the tank.

The portion *b* of the tank is provided with a discharge chute *l* near its upper end, into which material floating in the bath in portion *a* of the tank is discharged, and an inclined apron *m* extending beneath the liquid level in the portion *a* of the tank to a point beyond the center of the shaft *h*, which acts to support material carried by the conveyor to the chute *l*. The portion *c* of the tank is also provided with a discharge chute *n*, into which material sinking to the bottom of the portion *a* of the tank is discharged by the conveyor.

The portion *a* of the tank is provided with means for charging which comprise a hopper *z*, the bottom of which communicates with the interior of the portion *a* of the tank below the surface of the bath therein through a conduit *z'* in which is provided a suitably driven screw conveyor I, which extends below the level of the bath, which in the conduit coincides with the level in the tank. The screw, as will be noted, acts to enter material into the portion *a* of the tank and at the same time thoroughly mix it with the substance forming the bath.

The discharge chutes *l* and *n* are connected to conduits 2, which are arranged to discharge into opposite sides of buckets 3, the

bottoms of which are perforated, or formed by grids, and each of which is divided by a partition 24 and pivotally connected, by means of pivot pins 4, which pass through suitable lugs on the buckets, to form an endless chain passing around and driven by a sprocket 5 carried by a shaft 5*a*. The bucket chain is supported at its end opposite to the sprocket by means of a semi-circular rail section 6, suitably supported with its center above the center of the sprocket 5, and its upper and lower reaches are supported on a slant by suitably supported rail sections 7, which slant downwardly toward the sprocket, the rail sections being engaged by rollers 8 mounted on the pivot pins 4.

The conduits 2 are positioned to discharge into the buckets at one end of the upper reach and the buckets respectively are adapted to discharge on passing from the upper to the lower reach, as for example, in passing about the semi-circular rail section 6. At the discharge point of the conveyor there is provided a chute 9, divided by means of a partition 10, for the separate reception of material carried on opposite sides of the partitions dividing the buckets. The portions of chute 9 on opposite sides of partition 10 may be led to any desired points.

Extending beneath the upper reach of the bucket chain is a tank 11 connected to and supported by a pair of cranks 12 in turn secured respectively to suitably supported shafts 13. The tank 11 is supported on a slant substantially conforming to the slant of the rails 7 and of the upper reach of the bucket chain and is divided transversely by means of partitions 14 of a height slightly less than the height of the side walls of the tank and which are spaced apart longitudinally of the tank a distance somewhat greater than the length of the buckets 3. A pipe 15 connected to a suitable water supply is provided for the supply of water to the tank at its upper end adjacent the point of discharge of the buckets 3 and an overflow pipe 16 is provided at its lower end, it being noted that water supplied to the tank at its upper end will flow over the tops of the partitions 14 to the lower end.

The shaft 5*a*, which carries the sprocket 5 is adapted to be driven intermittently from a continuously driven shaft 17 through the medium of a pair of intermittent gears 18, 18′, while tank 11 is adapted to be raised and lowered toward and away from the buckets 3 through the medium of a cam 19, secured to the continuously driven shaft 17, and arranged to actuate cranks 12 by oscillation of shafts 13, through the medium of cranks 20 secured to shafts 13 and connected by a link 21 actuated by cam 19. The cam 19 is so designed that the tank 11 will be raised and lowered when the bucket line is intermittently at rest and will be in lowered position in which it will be clear of the buckets when the bucket line is intermittently moved.

As illustrative of the carrying out of the method in accordance with my invention with use, for example, of the apparatus above described, a bath comprising a solution of sodium thiosulphate, as a solution or melt of hydrated sodium thiosulphate in its water of crystallization, which may be obtained by heating hydrated sodium thiosulphate to its melting point, is provided in the tank section *a* to the level indicated at *k*. Coal, which may be anthracite or bitumious, suitably broken and admixed with impurities, as slate, shale, rock, etc., is introduced into the hopper *z*; from which it passes into the tank section *a* under the influence of screw I, which agitates it with the solution, and the conveyor set in motion to travel in the direction of the arrows.

The coal and impurities, as slate, separate in the bath due to the difference in specific gravity between the coal and the bath and between the waste and the bath. On separation the coal, having a lower specific gravity than the bath, floats or rises to the upper portion of the bath and is removed therefrom by the conveyor, the flights *f* of which, in cooperation with the apron *m*, carry the coal from the bath through the inclined tank section *b*, in which solution is drained from the coal back into the bath, and discharges it through chute *l*; while at the same time waste separated from the coal and which sinks in the bath, due to its higher specific gravity than that of the bath, is discharged through chute *n* by the conveyor.

The separated coal and waste discharged from the bath and carrying adhered sodium thiosulphate, pass through conduits 2 and are discharged into buckets 3 on opposite sides of the partitions 24 dividing the buckets. The coal and waste discharged into the buckets are then periodically washed by the raising of the tank 11, which is supplied with water from pipe 15, during the periods of rest of the bucket chain. The water supplied to tank 11 by pipe 15 overflows from section to section of the tank and the coal and waste carried by the buckets is washed in the several sections of the tank progressively from its lower to its upper end. Thus the wash water is counterflowed with the coal and waste so that the coal and waste carrying the greatest quantity of sodium thiosulphate is washed with water containing the greatest concentration of sodium thiosulphate, the concentration of sodium thiosulphate decreasing from section to section of the tank 11 as the amount of sodium thiosulphate carried by the coal and waste decreases. The overflow 16 from tank 11 may, if desired, be connected through the medium of a conduit 23 suitably connected to the overflow, to an evaporator 22, in which the salt may be recovered by evaporation of the water.

The coal and waste carried by buckets 3 after washing is discharged into chute 9 on opposite sides of partition 10 and led to any desired points.

It will be understood that my invention contemplates primarily the use of sodium thiosulphate as a separant for coal and impurities, as slate, shale, etc. It will also be understood that the method embodying my invention does not require for its practical adaptation any particular form of apparatus.

What I claim and desire to protect by Letters Patent is:

1. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising a solution of sodium thiosulphate of such concentration as to have a specific gravity substantially less than that of the impurities to be removed and greater than that of the coal and separately removing the coal and separated impurities from the bath.

2. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation and separately removing the coal and separated impurities from the bath.

3. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate at a temperature within about the range 32° C.–100° C., permitting separation of the coal and impurities by gravitation and separately removing the coal and separated impurities from the bath.

4. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and impurities from the bath, separating sodium thiosulphate from the coal and recovering the separated sodium thiosulphate.

5. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and impurities from the bath, washing the coal with water and recovering sodium thiosulphate from solution in the wash water.

6. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and separated impurities from the bath, counterflowing the coal and water and recovering sodium thiosulphate from the water.

7. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and separated impurities from the bath, immersing the coal at intervals in a stream of water and imparting intermittent movement to the coal in a direction counter to that of the stream of water.

8. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and separated impurities from the bath, immersing the coal in successive baths of water while maintaining a flow of water from the bath in which the coal is last immersed through intermediate baths to the bath in which the coal is first immersed.

9. The method of separating coal from impurities which includes introducing the coal and impurities into a bath comprising hydrated sodium thiosulphate in a melted state, permitting separation of the coal and impurities by gravitation, separately removing the coal and separated impurities from the bath, washing the coal with water in a series of batches, the wash water from one batch being delivered to the next batch throughout the series so that the batch last washed receives the wash water from previous batches of the series and the first batch washed receives pure water.

10. The method of separating coal from impurities which includes permitting the coal and impurities to separate in a bath of sodium thiosulphate containing water in quantity substantially equalling the water of crystallization of hydrated sodium thiosulphate.

In testimony of which invention, I have hereunto set my hand, at Philadelphia, Pennsylvania, on this 27th day of January, 1930.

FRANCIS I. DU PONT.